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(54) Diagnosing and treating chronic fatigue syndrome.

(57) Chronic Fatigue Syndrome is diagnosed and distinguished from other conditions presenting a similar clinical appearance by assessing the 2′-5′A oligonucleotide levels in the patient's circulating peripheral leucocytes and comparing the result obtained to that of healthy individuals. Double-stranded RNAs, notably mismatched dsRNAs, when administered in appropriate amounts, increase the 2′-5′A in patients with Chronic Fatigue Syndrome to normal levels and improve the clinical symptoms.

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DIAGNOSING AND TREATING CHRONIC FATIGUE SYNDROME

BACKGROUND OF THE INVENTION

Chronic Fatigue Syndrome (CFS), a condition involving some 10 to 12 million Americans, is a difficult to diagnose, ubiquitous disorder characterized by extreme fatigue, lymph gland enlargement and constitutional symptoms such as weight loss, loss of appetite and the like. The condition occurs primarily in young, active people. While some CFS patients manifest neuropsychiatric changes such as depression, loss of memory and similar derangements, chronic fatigue syndrome is sometimes difficult to distinguish from entirely neurological disorders, particularly depression. Various laboratory studies indicate that many different viruses may replicate in individuals having Chronic Fatigue Syndrome, and that these individuals become, in effect, "virus sewers". Viruses such as Epstein-Barr, cytomegalovirus, retroviruses, herpes viruses, etc., are often present in such individuals.

It has been determined that a specific deficiency in 2′-5′A molecules exists in individuals having Chronic Fatigue Syndrome, which deficiency has diagnostic significance of enormous value. As an illustration, consider that many 25-30 year old women with very active small children at home often complain of "chronic fatigue", but are not necessarily virus-manufacturing facilities. The diagnostic procedures here described enable the clinician to ascertain which patients presenting symptoms of chronic fatigue and related symptoms including in some instances loss of weight, loss of appetite and neuropsychiatric changes, are properly classified as having Chronic Fatigue Syndrome with associated viral involvement and accurately distinguishing such patients from those presenting fatigue symptoms caused by other often external reasons and/or depression. Proper diagnosis of Chronic Fatigue Syndrome is the necessary prerequisite to effective therapy. These valuable diagnostic procedures are described below.

In addition to these diagnostic procedures, the first definitive therapy for this disorder has been developed using various double-stranded RNAs to correct the disorder and successfully treat the patient's condition.

In previous studies, the diagnostic utility of components of the 2′-5′ oligoadenylate/RNase L pathway, as described in more detail below has been reported, as it relates to viral disorders in general and retrovirus infections in particular. Specifically, it has now been determined that in Chronic Fatigue Syndrome, among other things, a previously unknown viral-associated inhibitor of RNase L is present coupled with an abnormally low level of 2′-5′A in the patient's lymphocytes. These two measurements act as indicators or "markers" for Chronic Fatigue Syndrome and thus can be used to definitively diagnose the syndrome in a highly reliable manner. Further, the diagnosis is conveniently conducted from a patient's blood sample outside the patient's body.

DESCRIPTION OF THE INVENTION

This invention includes procedures for identifying Chronic Fatigue Syndrome, as evidenced by a viral-associated inhibitor of RNase L coupled with low level of 2′-5′A in the patient's peripheral blood lymphocytes, diagnostic procedures using this information to determine the presence of Chronic Fatigue Syndrome, therapeutic procedures for restoring the patient's 2′-5′A deficit such as by administering exogenous dsRNAs and improving the patient's clinical condition, therapeutic procedures for monitoring a Chronic Fatigue Syndrome patient's condition and gauging the degree of dsRNA replacement required on an individual basis, and therapeutic compositions for treating Chronic Fatigue Syndrome.

Diagnostic Procedures-

The in vivo concentration of 2′-5′A molecules in normal individuals and subjects with Chronic Fatigue Syndrome is assessed as follows: Ethanol-soluble fractions of patient samples (Ficoll-Hypaque-purified peripheral blood lymphocytes) were analyzed for their 2-′5′A content in 2′-5′A core-cellulose assays (affinity chromatography) with poly U-{^{32}P} -pCp. In this assay, the ability of 2′-5′A-activated RNase L to hydrolyze poly(U) is used to determine the concentration of functional 2′-5′A.

Reference values were established by testing 15 normal subjects with no recent history of viral

infections as evidenced by lack of fever, absence of constitutional symptoms, rashes, etc. Concentrations of their lymphocyte 2′-5′A levels were determined using calibration curves obtained with authentic 2′-5′A molecules. Normal individual reference values, expressed as nanamoles of 2′-5′A per gram of lymphocyte protein, are consistently within the range of 0.2 to 2.0.

Using the same assay method, ten patients exhibiting the usual symptoms of Chronic Fatigue Syndrome were tested and the results obtained were as follows:

Subject Number	n moles 2′-5′A per gram lymphocyte protein
1	<0.08
2	<0.05
3	<0.05
4	<0.05
5	nd*
6	nd*
7	<0.01
8	<0.01
9	<0.01
10	<0.08

* not detectable

Patients with Chronic Fatigue Syndrome have generally below 0.1 and always below about 0.2 n moles of 2′-5′A per gram of lymphocyte protein. Definitive treatment of such individuals with Chronic Fatigue Syndrome is provided by supplying exogenous dsRNAs, as required, until the intracellular level of 2′-5′A oligonucleotides reaches normal and/or the patient's clinical symptomology abates. The patient's resistance to Chronic Fatigue Syndrome and opportunistic viruses is maintained by continuing to measure the patient's intracellular 2′-5′A oligonucleotide levels and supplying exogenous dsRNA, as required, to maintain the 2′-5′A level in the normal range, usually in excess of 0.2 nanamoles of 2′-5′A per gram of lymphocyte protein.

The natural dsRNAs play a role in host defense when challenged with a viral disease such as Chronic Fatigue Syndrome. Specific reduction in bioactive dsRNA, or enzymes which depend on dsRNA, notably a viral-associated inhibitor of RNase L coupled with abnormally low levels of 2′-5′A in peripheral blood lymphocytes, within specific cells contributes to disease progression. dsRNA, notably mismatched dsRNAs, reverse disease progression.

By "mismatched dsRNA" are meant those in which hydrogen bonding (base stacking) between the counterpart strands is relatively intact, i.e., is interrupted on average less than one base pair in every 29 consecutive base pair residues. The term "mismatched dsRNA" should be understood accordingly. The dsRNA may be a complex of a polyinosinate and a polycytidylate containing a proportion of uracil bases or guanidine bases, e.g., from 1 in 5 to 1 in 30 such bases (poly I • poly(C_{4-29}x>U or G)).

The dsRNA may be of the general formula rI_n•$r(C_{11-14},U)_n$ or rI_n•$r(C_{12},U)_n$. Other suitable examples of dsRNA are discussed below.

The mismatched dsRNAs preferred for use in the present invention are based on copolynucleotides selected from poly (C_n,U) and poly (C_n,G) in which n is an integer having a value of from 4 to 29 are mismatched analogs of complexes of polyriboinosinic and polyribocytidilic acids, formed by modifying rI_n•rC_n to incorporate unpaired bases (uracil or guanidine) along the polyribocytidylate (rC_n) strand. Alternatively, the dsRNA may be derived from poly(I)•poly(C) dsRNA by modifying the ribosyl backbone of polyriboinosinic acid (rI_n), e.g., by including 2′-O-methyl ribosyl residues. The mismatched complexes may be complexed with an RNA-stabilizing polymer such as lysine and cellulose. These mismatched analogs of rI_n•rC_n preferred ones of which are of the general formula rI_n•$r(C_{11-14},U)_n$ or rI_nI•$r(C_{29},G)_n$, are described by Carter and Ts'o in U.S. Patents 4,130,641 and 4,024,222 the disclosures of which are hereby incorporated by reference. The dsRNAs described therein generally are suitable for use according to the present invention.

Other examples of mismatched dsRNA for use in the invention include: -

poly (I) • poly (C_4,U)
poly (I) • poly (C_7, U)
poly (I) • poly (C_{13},U)
poly (I) • poly (C_{22},U)

poly (I) • poly (C_{20},G)
poly (I) • poly (C_{29},G) and
poly (I) • poly C_{p23} G>p

2′-5′A concentration and molecular size may be quantitated by high pressure liquid chromatography (HPLC). Ribosomal RNA cleavage assays may be used to assess biological functionality (activity) of the 2′-5′A-synthesized by the patient in vivo or to determine the level of activated RNase L in patient samples. Peripheral mononuclear blood cells are the preferred cells for analysis.

Patients having Chronic Fatigue Syndrome are treated with intravenous infusions of 200 to 250 mg of rI•r(C_{11-14},U) twice weekly and 2′-5′A levels increase in association with clinical improvement. The amount of dsRNA administered and the frequency of administration will be guided by the 2′-5′A levels measured in conjunction with the patient's clinical improvement. Amounts of dsRNA administered will provide a level of from 0.01 to 1,000 micrograms of dsRNA per milliliter of the patient's systemic blood circulation immediately following administration measured at a point distal from the point of infusion.

Claims

1. A method of diagnosing chronic fatigue syndrome in a human patient comprising assessing the level of intracellular 2′-5′A oligonucleotides in a sample of the patient's peripheral blood and comparing same to predetermined levels of 2′-5′A oligonucleotides in healthy individuals, reduced 2′-5′A oligonucleotide levels as compared with those in healthy individuals indicating the presence of chronic fatigue syndrome.

2. A method of distinguishing viral-induced chronic fatigue syndrome from primary psychological or neuropsychiatric disorders resembling same in a person comprising assessing the level of intracellular 2′-5′A oligonucleotides in a sample of the patient's peripheral blood and comparing same to predetermined levels of 2′-5′ oligonucleotides in healthy individuals.

3. The method of claim 1 or claim 2 in which the 2′-5′A oligonucleotide is 2′-5′ oligoadenylate.

4. The method of claim 1 or claim 2 in which the diagnosis is presumptively positive for chronic fatigue syndrome when the 2′-4′ oligonucleotide in the patient sample is less than 0.2 nanomoles of 2′-5′A per gram of lymphocyte protein.

5. Use of a mismatched dRNA for the manufacture of a medicament for treating viral-induced chronic fatigue syndrome.

6. Use of claim 5 in which the mismatched dsRNA is polyadenylic acid complexed with polyuridylic acid.

7. Use of claim 5 in which the mismatched dsRNA is a complex of a polyinosinate and a polycytidylate containing from 1 in 5 to 1 in 30 uracil or guanidine bases.

8. Use of claim 7 in which the mismatched dsRNA is rI_n•r(C_{11-14},U)$_n$ or the mismatched dsRNA contains regions of bond breakage and exhibits the favorable therapeutic ratio property of rI_n•r(C_{11-14},U)$_n$.